STANDARD OPERATING PROCEDURE

Cover Sheet

Division serial number

Issue Date: Aug 29, 2003	
Title: High Voltage Conditioning of the Polarized Photoguns	
Location: Accelerator Tunnel - Injector	
Author: M. Poelker, rev. M. Stutzman	
Risk classification (See EH&S Manual Chapter 3210.)	
	Without mitigation measures: 3 and 4
	With specified measures implemented: 0

Supplemental Technical Validations:	
Hazard reviewed:	**Reviewer signature:**
Electrical shock	B. Merz
Ionizing radiation	E. Abkemeier
Non-ionizing radiation	P. Hunt
Lockout/Tagout	E. Hanson

Management/EH&S Approval	**Signature:**
Division EH&S Officer	B. May
Department Head	A. Hutton

Coordination	**Signature:**
Operability Group Leader	S. Suhring
Safety Systems Group Leader	K. Mahoney

Standard Operating Procedure (SOP) for High Voltage Conditioning of the Polarized Photoguns at the JLab Injector

Matt Poelker 3/26/02
rev. Marcy Stutzman 8/29/03

Introduction

There are two high voltage photoelectron guns at the JLab injector tunnel. These guns operate at –100 kV, with high voltage applied to only one gun at any given time. Under normal accelerator operations, the Personnel Safety System (PSS) ensures that gun high voltage is applied only in "Beam Permit", i.e., when all personnel have left the accelerator tunnel.

Occasionally, however, a gun must be "high voltage conditioned". This is a process where gun voltage is applied beyond the normal operating voltage (to -120 kV rather than -100 kV) in an attempt to eliminate unwanted field emission from the gun cathode electrode. Field emission sometimes develops within a gun over time, or sometimes it is present only during the initial high voltage processing of a new electrode. No matter what the source, field emission must be eliminated to ensure long lifetime performance of a JLab photoelectron gun.

This document describes a Standard Operating Procedure (SOP) for gun high voltage conditioning during periods when the machine is in Restricted or Controlled Access.

Responsibility and Authority

Responsible supervisor: Matt Poelker
For a current list of Hi-potter operators and sentries, see appendix 1.

Training Requirement

Lock, Tag and Try
ODH
Rad Worker I

Hazard Analysis

The hazards associated with the Hipotting procedure include high voltage and exposure to x-rays. These hazards, their causes, and mitigation are discussed in the following tables.

Risk Assessment

Severity of outcome	Personal injury	Property loss, environmental impact		**Risk**	**Code**	
IV	Death or permanent disability	> $100,000	**1**	**3**	**4**	**4**
	Hospitalization	>$10,000				

III	required or ≥ 5 lost workdays		**1**	**2**	**3**	**4**
II	First aid or medical treatment, <5 lost days	>$500	**0**	**1**	**2**	**3**
I	First aid not required	<$500	**0**	**0**	**1**	**1**
			> 500 years	≤ 500, but >10 years	≤ 10 years, > 10 days	≤ 10 days
			A	**B**	**C**	**D**

Likelihood of accident

Hazard Analysis for Gun High Voltage Conditioning

Cause	**Hazard**	**Risk Code Pre**	**Mitigation** Administrative	**Mitigation** Engineering	**Risk Code Post**
Field emission associated with operation of high voltage power supply	X-ray exposure	3	Exclusion of personnel from the area, by use of ropes and sentries. Sentries will wear TLD badges		0
Exposure to high voltage	electrocution	4	Use the Hipotter according to the operators manual: there will be no high voltage exposure from the hipotter to the gun. Power supply is locked out whenever cables are handled		0
Photemission caused by light hitting the gun cathode	X-ray emission	3	Light source for the gun is locked out. Other inadvertent light sources will be turned off.		0

Description of hazards associated with high voltage conditioning

There are two hazards associated with this task;
1) Exposure to High Voltage
2) Exposure to x-ray radiation as a result of field emission within the photogun cathode electrode (energetic, field-emitted electrons may strike the vacuum chamber walls producing x-rays). Radiation exposure levels at one foot may exceed 1000 mrem per hour.

Mitigation of Hazards

Steps will be taken to ensure that no exposed high voltage is present during gun high voltage conditioning. A commercial high voltage power supply (aka "hi-potter") is used for the procedure. Cables must have proper shielding. The aluminum shroud must be attached to the photogun under test to isolate the high voltage section of the gun.

The x-ray hazard is mitigated because all personnel must leave the injector portion of the tunnel before high voltage conditioning can begin. The distance between the photogun position and the injector gate, 70 ft, is sufficient x-ray hazard mitigation for individuals remaining outside the injector gate. High voltage is applied to the gun from the injector service building (ISB); no one is in the injector tunnel near the gun during the procedure. Sentries are stationed outside the gate in the injector and at the top of the stairs of the injector service building to ensure that nobody enters during the hipotting. Furthermore, the gun will be roped off and a sign will be posted near the gun describing the hazard. The rope will prevent personnel from approaching to within a few feet of the gun under the unlikely circumstance that someone gets past the sentries posted at entry ways to the injector tunnel.

The lasers will be off and LOTO according to the polarized source LSOP during the procedure to prevent photoemission of high voltage electrons from the gun. Other light sources such as vacuum gauges shall also be turned off to prevent photoemission of high voltage electrons. All windows into the gun will be covered securely to prevent light leaks.

These measures are described in detail in the Requirements section of the document below.

Requirements for High Voltage Conditioning of JLab Photoguns during Restricted or Controlled Access.

High Voltage Power Supply:
Either Glassman or Hypotronics (referred to as the "hi-potter");
1) The hi-potter (maximum voltage –125 kV) has current limiting capability. The current-limit feature limits current to < 10 microA.

2) The hi-potter must accommodate a lock-out device in accordance with JLab's lock-out/tag-out policy. In this case, the male plug of the 120 VAC or 208 VAC power cord can be secured within a lock-out box.
3) The high voltage cables that connect the hi-potter and the photogun must fit properly within each receptacle.

Removal and insertion of high voltage cables;

1) Personnel conducting this procedure must follow the standard procedure for locking and tagging out the high voltage power supply before manipulating any cables in the switchbox. The procedure is attached as appendix 2.
2) The hi-potter must be unplugged and locked-out to ensure that high voltage is off when the cables are attached or removed from the gun under test.
3) Manipulation of the High Voltage Cables at the gun will be performed according to the standard procedure (see appendix 2)

Securing the area of potential hazard;

1) The injector area must be "swept". All personnel must leave the injector tunnel.
2) There must be at least one person stationed at the hi-potter while it is energized. The hi-potter Operator will not serve as a sentry to limit access to the tunnel.
3) There must be one person stationed at the top of the stairwell in the ISB to prevent access to the Injector tunnel.
4) There must be one person stationed outside the injector gate where they can prevent any personnel from entering the injector area (cryomodule 0L04, phone x6208 or west arc, phone x5388). This sentry will be wearing a TLD badge and will be trained as a JLab Radiation Worker as required by the General Access Radiation Work Permit.

Preventing photobeam production from the gun under test.

1) The lasers will be OFF and the lasers will be LOTO according to the LSOP.
2) Gun vacuum windows will be covered to prevent inadvertent photoemission.
3) Filaments will be turned off on the gun vacuum gauges to prevent inadvertent photoemission (residual gas analyzer and extractor gauges produce light when the gauge filaments are ON).

Procedure

1) One person is designated by the injector group to be the hi-potter Operator. The hi-potter Operator coordinates the implementation of this procedure (i.e., the hi-potter Operator is in charge). At least two others must participate in this procedure to serve as sentries. The sentries will be instructed by the hi-potter Operator. Qualified personnel are listed in appendix 1.
2) Alert the Safety System Group Leader or Deputy that high voltage conditioning of a photogun is to be performed. They will attach an administrative lock to the breaker that feeds the permanent Glassman gun high voltage power supply. The PSS group Administrative LOTO is to ensure that the system is back in a proper configuration before the procedure is finished. This can be done ahead of the scheduled hi-potting.
3) Alert Operability Group Leader that high voltage conditioning of a photogun is to be performed.
4) Alert the PD that the high voltage conditioning of a photogun is to be performed.
5) Have an announcement made over the public address system that the gun is going to be hi-potted and there will be no entry to the injector.
6) Post signs warning of the x-ray and high voltage hazards at the top of the ISB stairs, around the gun, and at the injector gate.
7) Notify the Radiation Control Group that the proper radiation control signs have been posted at the injector gate by the Electron Gun Group.
8) In the Injector tunnel, the gun high voltage cable is attached to the gun under test in accordance with the approved procedure for handling gun high voltage cables (appendix 2). The aluminum high voltage shroud is attached to the gun.
9) Ensure that all vacuum gauges are off and all windows into the gun are covered to prevent photoemission.
10) Lock out the laser power supplies in according to the polarized source LSOP.
11) The Injector tunnel is swept. Injector occupants are required to leave. Any workers working near but not in the injector area of the tunnel are notified that this procedure is about to start.
12) Have the sentries take their places at the west arc and at the top of the ISB stairwell. Throughout the high voltage conditioning procedure, the hi-potter Operator is in verbal communication with the ISB sentry. The hi-potter Operator and the sentry at the west arc are in communication via telephone.
13) Verify that the hi-potter is OFF and locked out by attaching a LOTO device to the end of the 120VAC or 208VAC power cord.
14) The high voltage cable for the gun under test is removed from the Ross switch box and is inserted into the hi-potter.
15) Call the sentry on the phone at the west arc to verify “all is well” and that no one has entered the Injector Tunnel. Similarly, the hi-potter Operator discusses with the sentry at the ISB that no one has entered the Injector Tunnel.
16) The lock out device is removed from the hi-potter.
17) The hi potter is energized, turned on and voltage is applied to the gun under test.
18) Gun high voltage conditioning ensues; high voltage up to –120 kV is applied to the gun while field emission is monitored via the beamline viewer immediately downstream of the gun (seen on a video monitor in the ISB). Vacuum Pressure (via

ion pump current) in the gun chamber is also monitored via epics and/or by watching the ion pump current power supply in the ISB.

Backout Procedure

1) The gun high voltage is turned down to zero volts and the hi-potter is turned off.
2) The hi-potter is unplugged from the 120 VAC or 208 VAC outlet and locked-out.
3) The high voltage cable is removed from the hi-potter, making sure to ground it with the grounding rod as it is removed. Hold the center conductor to the ground rod for several seconds to ensure that it is also de-energized.
4) The high voltage cable is returned to the appropriate receptacle in the Ross switch box.
5) Notify all sentries that the procedure is finished.
6) Remove all notices prohibiting entry to the injector tunnel area.
7) The LOTO device for the lasers can be removed.
8) Inform the Operability Group Leader or Deputy that the procedure is complete.
9) Alert the Safety System Group Leader or Deputy that the procedure is complete and that a functional re-certification of the gun high voltage power supply is warranted.
10) Alert Radiation Control Group Leader or On-call that the procedure is complete and remove the RadCon postings from the Injector Gate and service building.

Appendices:

1) Lists of Personnel
2) Instructions for handling gun high voltage cables. This document describes the approved lockout/tagout procedure for manipulating cables at the blue high voltage Ross switch box and at the polarized source guns.

Emergency Procedures

In case of injury to personnel:

call 911 if warranted
contact the crew chief
call the guard shack

Appendix 1

Operators of Hi-potter
Phil Adderley
Maud Baylac
Josh Brittian
Joe Grames
John Hansknecht
Matt Poelker
Marcy Stutzman

Sentries:
Phil Adderley
Maud Baylac
Daniel Charles
Jim Clark
Joe Grames
John Hansknecht
Matt Poelker
Marcy Stutzman
Any Operations Staff who read this procedure and sign that they understand their duty

Notification List:

Safety System Group Leader: Kelly Mahoney x7024
Safety System Group Deputy: Henry Robertson x7285
Operability Group Leader: Steve Suhring x7670
Operability Group Deputy: Jack Ludwig x7416
Radiation Control Group Leader: Erik Abkemeier x7551
Radiation Control Group Deputy: Keith Welch x7212
Radiation Control On-call: 876-1743
Crew Chief On-call: x7045 or 630-7050
Guard Shack in case of emergency x4444